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THE RELATIONSHIP OF REACTIVE INHIBITION AND SCHOOL ACHIEVEMENT--THEORY, RESEARCH, AND IMPLICATIONS.

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THE RELATIONSHIP OF REACTIVE INHIBITION TO TEST PERFORMANCE AND TO ACHIEVEMENT IN READING, SPELLING, AND HANDWRITING WAS STUDIED. IN THIS STUDY, AS IN PREVIOUS WORK DONE BY HALL (1943), REACTIVE INHIBITION IS DEFINED AS THE ACCUMULATION OF A GRADUAL DECREASE IN THE LEVEL OF PERFORMANCE THAT RESULTS FROM THE PERFORMANCE ITSELF. WHEN GIVEN A LOW LEVEL OF MOTIVATION, POOR ACHIEVERS APPEARED TO ACCUMULATE REACTIVE INHIBITION MORE RAPIDLY THAN GOOD ACHIEVERS. BOTH THE PERFORMANCE AND THE REACTIVE INHIBITION OF GOOD ACHIEVERS APPEAR TO INCREASE WHEN MOTIVATION IS INCREASED, BUT NO SUCH EFFECT WAS DEMONSTRATED WITH POOR ACHIEVERS. FURTHER STUDY IS SUGGESTED ON THE PRODUCTION OF REACTIVE INHIBITION CAUSED BY (1) SIMPLE AND COMPLEX TASKS AND (2) THE INTERACTION OF ANXIETY AND MOTIVATIONAL LEVELS. (AL)

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Wayne O'...

RESEARCH AND DEVELOPMENT CENTER FOR LEARNING AND RE-EDUCATION

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Occasional Paper No. 4

THE RELATIONSHIP OF REACTIVE INHIBITION AND SCHOOL ACHIEVEMENT: THEORY, RESEARCH, AND IMPLICATIONS

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PREFACE

The R & D Center for Learning and Re-Education has as its primary goal the improvement of cognitive learning in children and adults, commensurate with good personality development. Through synthesizing present knowledge and conducting research to generate new knowledge, we are extending the understanding of human learning and the variables associated with efficiency of school learning. Knowledge is being focused upon the three main problem areas of the Center: developing exemplary instructional systems, refining the science of human behavior and learning on the one hand and the technology of instruction on the other, and inventing new models for school experimentation, development activities, etc.

Professor Wayne Otto has been concerned with reading ability and its improvement for a number of years and has, as a Principal Investigator, brought this concern to the R & D Center. In this Occasional Paper, Dr. Otto discusses reactive inhibition as a cause for learning disabilities in reading and in other areas basic to all school learning.

Herbert J. Klausmeier
Co-Director for Research

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ABSTRACT

This paper examines the relationship of reactive inhibition to achievement in the basic school subjects in the light of theory and existing research. With an underlying assumption that at least the early stages of basic skill learning take place by operant conditioning, inhibitory potential may be a potent determiner of later achievement. The construct of reactive inhibition is placed in a Hullian framework, but the relationship to Eysenck's personality dimension of introversion-extraversion is noted. Studies placed within each framework are examined and found generally to offer support for the theoretical deductions. Limitations of the existing research, implications for practice, and promising leads for research to elucidate the demonstrated relationship are discussed. The overall conclusion is that the construct of reactive inhibition ought to be considered both in research and practice in the area of remedial education.

I
INTRODUCTION

Since Eysenck (1957) theorized that a basic dimension of personality, extraversion-introversion, is a function of excitation-inhibition, there have been a number of attempts to explore the relationship of inhibitory potential to school achievement. The purpose of this paper is to review the theoretical framework for such attempts, to examine briefly the results of selected studies, and to suggest implications for research and for practice. There is only incidental concern with reactive inhibition as a broad theoretical construct: the focus is upon the role of reactive inhibition in influencing school achievement in the basic skill areas.

II

THE THEORETICAL FRAMEWORK

Reactive inhibition was first incorporated into learning theory and systematically explored by Hull (1943), although Pavlov (1927) had talked about "excitation" and "inhibition" somewhat earlier. Other writers have since used the term, but apparently with a certain amount of ambiguity. Hull conceived reactive inhibition as the accumulation of a performance decrement that results from the performance itself; thus, it amounts to a negative drive that is akin to tissue injury, fatigue, or pain. In a Hullian framework reactive inhibition can be elicited experimentally, particularly under massed practice conditions, and quantified by comparing performance immediately preceding and immediately following rest. Eysenck and Rachman (1965, p. 34) refer to this performance-induced negative drive as temporal inhibition and apply the term spatial inhibition to the performance decrement produced by simultaneous action (distraction). Pavlov called the former internal and the latter external inhibition. In this discussion the term reactive inhibition is used in the Hullian sense.

Eysenck's personality dimension of extraversion-introversion is similar to Hull's reactive inhibition construct in that the assumption is that extraverts generate reactive inhibition quickly and dissipate it slowly and introverts generate slowly and dissipate quickly. Whatever the terminology, the expectation is that individuals who accumulate reactive inhibition rapidly (extraverts) will condition slowly because the rapid buildup of negative drive detracts from excitatory potential (total capacity to respond). This expectation has been directly confirmed by Franks (1957). Similarly, if conditioning is a function of an excitation-inhibition ratio, then the intake of stimulant drugs which produce excitation and depressant drugs which produce inhibition should yield conditioning curves similar to those produced, respectively, by introverts and extraverts. This, too, has been confirmed (Franks & Trenton, 1958).

In the present context reactive inhibition becomes a factor to be considered in school learning if one accepts the conclusion of Peel (1956) and others that the early stages of such learning take place by instrumental conditioning (e.g., in beginning reading or arithmetic the task is essentially the formation of stimulus-response connections: C-A-T → cat, 3+1 → 4). Then pupils who condition quickly ought to learn to read more efficiently than pupils who condition more slowly. Thus, insofar as it detracts from excitatory potential—in the present paradigm, ease of conditioning—a tendency to accumulate reactive inhibition is likely to contribute to learning difficulties. A number of studies discussed in the following section of this paper offer support for such a prediction.

III

RESEARCH RESULTS

Some researchers have studied adult performance on school-like tasks through Eysenck's extraversion-introversion dimension. Himmelweit (1945), for example, found that introverts had better vocabularies in relation to their intelligence than did extraverts. This is in line with the theoretical deduction that introverts will develop into better readers than extraverts because the former accumulate reactive inhibition slowly and condition rapidly. Foulds (1951), with a Matrices Test, and Eysenck (1959), with an intelligence test, found that extraverts' performance deteriorated more than introverts' toward the end of the test. Here again the theoretical deduction is supported: extraverts will do less well toward the end of a test because their rapid accumulation of reactive inhibition detracts from sustained optimum performance.

Rankin (1962) did an explicit study of the reading test performance of introverts and extraverts. As expected, he found that although the two groups did not differ in total errors on the first third of the test, they did differ significantly on the middle and final thirds, with the extraverts making more errors despite the fact that there was no increase in item difficulty. There was also reason to question the validity of the test for extraverts, for while the reading test scores of introverts were correlated significantly with their academic grades in college the scores of extraverts were not. The latter finding could be predicted on the grounds that when rapid accumulation of reactive inhibition lowers test reliability, validity is also decreased.

Lynn (1960) studied the inhibitory potential of elementary school children in an attempt to bring together post hoc speculation based upon the extraversion-introversion dimension and explicit prediction employing the reactive inhibition construct. Using an inverted digit printing task to quantify reactive inhibition, he tested the hypothesis that individual differences in the generation of reactive inhibition (inhibitory potential) will correlate with differences in reading attainment. The significant negative correlation demonstrated between accumulated reactive inhibition and reading ability suggests, as expected, that the more rapidly reactive inhibition is accumulated the less adequately reading skill is acquired.

An explanatory interjection is in order here. A number of tasks have been used to quantify reactive inhibition. They commonly include a number of trials, over several minutes' time, of massed practice, a rest period of two or more minutes, and one or more post-rest trials. The gain in performance from last pre-rest to first post-rest trial, referred to in the literature as reminiscence, is assumed to be due to the dissipation of reactive inhibition; thus, the greater the reminiscence the greater the accumulation of reactive inhibition. A more direct measure of reactive inhibition might be expected from a comparison of performance on first and last pre-rest trials; but the picture is confounded by the fact that performance may be increasing due to practice but limited by accumulating reactive inhibition, and it is difficult to extricate the separate effects of each. A commonly used task with adults is inverted alphabet printing: subjects simply print inverted letters as rapidly as possible over the trials allotted. Inverted number printing, as used by Lynn, has worked out better with children, especially poor readers who typically have difficulty even with the upright alphabet. See Kimble (1949) for a detailed discussion of reminiscence and the effects of reactive inhibition.

In the first of a series of studies, Otto and Fredricks (1963) corroborated Lynn's finding that inhibitory potential and reading attainment are negatively related. Good and poor readers in Grades 4, 5, and 6 performed the inverted-digit printing task. The groups did not differ in initial performance; but the poor readers showed significantly greater reminiscence, the implication being that they had accumulated more reactive inhibition before rest. The inverted-number printing task is described in

detail in the report of the study.

The above study was replicated with all Negro subjects with the same general results (Otto, 1966). It had been expected that the interaction of white examiner and Negro subjects might affect performance on the digit printing task. Thus, the study demonstrated the generality of previous relationships and the appropriateness of the digit printing task. Comparison of pre-rest performance also showed that while the good and poor readers did not differ in performance on the initial trial, the good readers were producing significantly more inverted numbers by the last pre-rest trial. This would be predicted, of course, because of poor readers' more rapid accumulation of reactive inhibition; but in many studies acceptable significance levels are not reached for pre-rest performance differences despite highly significant differences in reminiscence.

The relationship between inhibitory potential and skill attainment in the basic skill areas of arithmetic, handwriting, and spelling was examined in another study (Otto, 1965). Subjects were 220 good and poor achievers in the several skill areas from Grades 4 through 8. The predicted relationship was demonstrated for handwriting and spelling: the poor achievers dissipated more reactive inhibition during rest than did the good achievers. But the relationship did not hold for arithmetic: the good achievers produced many more digits than the poor achievers and they did not differ from poor achievers in reactive inhibition dissipated during rest.

In the present framework, increased motivation should cause both increased performance and—because there is less resting while working and, therefore, less spontaneous dissipation of reactive inhibition—greater accumulation of reactive inhibition. The validity of such a prediction was supported by the results of a study by Wasserman (1951). Thus, there was cause for speculation that the performance of good achievers in arithmetic may have been due to inherent motivation to do well on a success-associated task like number printing. If this is in fact true, then high extrinsic motivation should produce similar results with good achievers in other skill areas. Furthermore, the related expectation would be that increased motivation would worsen poor achievers' already present tendency to accumulate reactive inhibition rapidly. Another study (Otto, 1965) reported in the same article as the study just described, was designed to examine these notions.

In the first phase of the study, 60 good and poor spellers in Grades 4 through 6 served as subjects. Procedures of the earlier studies were replicated, except that good spellers were given instructions intended to be highly motivating. Whereas the original instructions were designed merely to secure cooperation without anxiety, the revised instructions were designed to produce ego involvement in the inverted-number printing task and, presumably, higher motivation. With the revised instructions, good spellers' performance was similar to that of good achievers in arithmetic. In fact, they not only produced more digits, but they also dissipated significantly more reactive inhibition than the poor spellers, which was in complete accord with the prediction. In the second phase, 60 good and poor readers in Grades 4 through 6 were subjects, but the poor readers got the revised instructions. Here the results did not support the prediction. The ostensibly highly motivated poor readers produced no more inverted numbers than the presumably less highly motivated good readers although they did, as before, dissipate more reactive inhibition during rest. The revised instructions, then, had no clear effect upon poor readers' performance. Whether highly motivated poor achievers simply cannot produce more digits or whether motivating instructions have no effect or even a debilitating effect upon poor achievers' performance is not clear from the data. The possibility that motivating instructions may have differential effects upon the performance of good and poor achievers is intriguing. Studies like one recently reported by Van De Riet (1964), where the suggestion was that good and poor achievers respond differently to praise and reproof, lend some support to such a notion.

In another study, Otto (in press) examined the relationship between subjects' anxiety level and inhibitory potential. If anxiety is equated to drive, the prediction follows that high anxious subjects will produce more work and therefore, accumulate more reactive inhibition than low anxious subjects in a given period of time. One main purpose of the study was to test the validity of the prediction. A second purpose was to examine the possible interaction between different levels of motivation and anxiety. The notion was that different motivation levels might produce different results with high and low anxiety subjects, just as with good and poor achievers, despite the theoretical implication that anxiety and motivation ought to be cumulative aspects of drive. The Children's Manifest Anxiety Scale (Castanada, McCandless, & Palermo, 1956) was used

to identify 120 pupils in Grades 4 through 6 who scored high (top 20%) or low (bottom 20%) on the scale. Equal numbers of subjects were given instructions intended to evoke high or low motivation. Performances of high and low anxious subjects with high motivation and high and low anxious subjects with low motivation were compared by analyses of variance. The theoretically derived expectation was only partially confirmed. With high motivation, high anxious subjects accumulated more reactive inhibition than low anxious subjects; but with low motivation high and low anxious groups did not differ. The interpretation offered was that anxiety level may become a relevant factor only after a critical level of motivation has been reached.

Most recently, Schoer (1966) studied the relationship between college students' inhibitory potential and their performance on programed learning materials. A digit cancellation task, where the subjects cross out all the 5's in rows of random numbers, was used to identify fast and slow accumulators of reactive inhibition. Results indicated that rapid accumulators made fewer errors than slow accumulators on a posttest. The expectation had been that since learning by programed instruction presumably is by operant conditioning the result would be the opposite to that demonstrated. In explaining the results, Schoer suggested that reactive inhibition, like anxiety, may have a positive effect upon performance on simple tasks, but a negative effect when the task is more complex. The notion is an interesting one that deserves further investigation. At this time, however, it seems that a more straightforward explanation might be suggested: the digit cancellation task itself may have been inadequate. Subjects had only three minutes to practice before rest and just one minute to dissipate their reactive inhibition; whereas, traditionally both practice and rest periods have been longer. That Schoer's subjects failed to show a predictable reminiscence effect supports this speculation. The digit cancellation task ought to be checked out with younger subjects, but with longer practice and rest periods to insure reasonable stability of the measure. It deserves to be checked out, because digit cancellation promises to be an easier task to administer, especially with young children, than inverted number printing.

To sum up, a relationship has been demonstrated between inhibitory potential and (a) test performance, and (b) reading, spelling, and handwriting attainment. Given a fairly low level of motivation, poor achievers appear to accumulate reactive inhibition more rapidly than good achievers. There is evidence that good achievers' performance and inhibitory potential both increase when motivation is increased; but no such effect has been demonstrated with poor achievers. The role of general anxiety in producing such results is not yet clear; but careful study of the effect of the interaction of anxiety and motivation levels upon inhibitory potential may help to explain some of the previous findings. The notion of a differential effect of reactive inhibition with simple and complex tasks offers an opportunity for speculation and research.

IV
IMPLICATIONS

Obviously it would be premature to make anything but tentative suggestions for practice in remedial education on the basis of the existing studies; nevertheless, the promise of implications is intriguing. The remainder of this discussion is, therefore, devoted largely to speculation regarding future research and application.

In a strict Hullian framework, the theory has it that over a period of time the accumulation of reactive inhibition, which has but a temporary effect, leads to conditioned inhibition, which does not dissipate but becomes a permanent performance decrement. Awkwardly, though, to accept conditioned inhibition, with its permanent effect, in a skill learning situation would be to reject any expectation of positive results from corrective or remedial teaching. In practice, the construct of conditioned inhibition has fallen into disrepute because it fails to hold up well in experimental situations; and that underachievers do respond to remedial teaching bespeaks the fact that their disability is not permanent. Nevertheless, inefficient learning precipitated by too rapid accumulation of reactive inhibition could contribute to a lack of early skill mastery and resultant chronic underachievement without dependence upon the construct of conditioned inhibition. To suggest such a causal relationship on the basis of the studies reviewed here seems defensible.

While a causal relationship is implied, it should be clear that, at this stage of investigation, the cause-effect relationship of inhibitory potential and skill attainment is not yet definitive. One might argue, for example, that failure in basic school subjects and the tendency to rapidly accumulate reactive inhibition spring from a common causal factor. Or, perhaps repeated failure in skill learning predisposes underachievers to withdraw early from full participation in a massed practice situation despite reasonable initial effort; the causal relationship, then, would be the opposite of that suggested. A study of inhibitory potential in kindergarten children designed to predict future skill attainment on the basis of their tendency to accumulate reactive inhibition rapidly or slowly would help to supply the definitive information that is needed.

Meanwhile, if the demonstrated relationships are accepted at face value, then there is a clear implication for practice in remedial teaching. The fact that underachievers tend to accumulate reactive inhibition rapidly suggests that teachers need to be concerned with distribution of practice in remedial sessions. Action studies designed to set up efficient work-rest patterns, both for groups and for individuals, will be useful. Likewise, clinical studies that systematically examine individuals' anxiety level, motivation, and inhibitory potential as related to their response to remedial instruction will be worthwhile. The interactions among these several factors make clear the limitations of group study and the need for close scrutiny of the idiosyncratic responses of individuals.

The test performance of fast and slow accumulators of reactive inhibition needs to be examined systematically. Studies by Rankin and others suggest that because accumulating reactive inhibition interferes with performance late in a test, rapid accumulators' scores are neither reliable nor valid. Interspersed rest periods ought to compensate, but restandardization of the tests involved will be necessary. As it is, the confounding of inhibitory potential and test performance is likely to make for spuriously high relationships between inhibitory potential and skill attainment in studies where test scores are used exclusively (e. g., rapid accumulation of reactive inhibition results in poor test performance, low test scores are used to identify underachievers, underachievers accumulate reactive inhibition rapidly in experimental tasks). Teacher corroboration, based upon classroom observation, of subjects' test scores can serve to minimize this effect, however.

As already suggested, it will be worthwhile

to examine the validity of the digit cancellation task as a measure of reactive inhibition in children. Replication of any of the earlier studies that employed inverted number printing would yield pertinent information. Regardless of the findings, there should be a direct test of Schoer's (1966) suggestion that reactive inhibition may have differential effects upon learning tasks that differ in complexity. This could be accomplished readily by having good and poor achievers who do in fact differ in inhibitory potential master a simple laboratory-type learning task and then by noting the nature of group differences, if any, on the task. While a differential effect seems illogical, such an effect has been demonstrated with anxiety level. Furthermore, in defending the prediction one might argue that rapid accumulators of reactive inhibition may develop a compensatory set that sustains for short work periods but yields to critical amounts of reactive inhibition. Such an expectation would be in line with Otto's (in press) finding that anxiety level affects inhibitory potential only when motivation is high (i.e., the subject is able to compensate up to a point).

Many other studies are needed before the nature of reactive inhibition and its role in basic skill attainment will come into useful focus. The suggestions given are only illustrative. As it is, the basic relationship of inhibitory potential and skill attainment seems reasonably clear, but the wide variety of possible interactions tends to blur the picture. Yet the promise of ultimate usefulness of the construct of reactive inhibition in remedial education seems sufficiently great to merit further interest and study.

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